

# Cognitive aging and the effect of mild head injury

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## Chapter 13

### Cognitive aging and the effect of mild head injury

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#### ABSTRACT

The present study investigates the possible interaction of age and mild head injury (MHI) in their effect on neurocognitive performance. The possible long-term sequelae of MHI were tested in groups of middle-aged and old MHI subjects who had sustained an accident on average 30 years ago, versus matched controls. The results show that MHI subjects who were subjectively healthy were characterized by performance decrements on the Verbal Learning test and the Stroop test. In addition, the data suggest that MHI sustained many years earlier may shift the effect of age on cognitive functioning to a younger age. This substantiates the notion that MHI can act as a Biological Life Event.

#### INTRODUCTION

It has been amply documented that there is an age-related decline in cognitive functioning, as found in tasks involving the processing of new information and the planning of new activities (e.g., Botwinick, 1981; Craik & Byrd, 1982). In addition, there is a general slowing of behaviour (Salthouse, 1985). Houx and Jolles found that factors which are implicated in suboptimal brain health may accentuate the effect of 'normal' biological aging in subjects who consider themselves to be normal and healthy (Houx, Jolles & Vreeling, 1993; Houx, Vreeling & Jolles, 1991a, 1991b, 1993). They hypothesized that slight cognitive changes and slowing in task performance might become manifest in middle age, when the normal biological aging process becomes evident, especially when a 'Biological Life Event' (BLE) is present (a discussion of the BLE-concept can be found in Chapter 2). An important BLE appears to be mild head injury (MHI).

MHI can give rise to the development of postconcussional symptoms, in which both physiogenic and psychogenic factors have an important role

(Brown, Fann, & Grant, 1994). Postconcussional symptoms can persist up to 3–5 years (Edna & Cappelen, 1987), thus invalidating the traditional view that mild to moderate head injury involves an essentially reversible physiological process (Levin, Mattis, Ruff, Eisenberg, Marshall, Tabaddor, et al., 1987). Among others, age has been identified as a possible risk factor for persisting postconcussional symptoms (Edna & Cappelen, 1987). Mazzucchi showed diffuse deterioration in 28%, moderate deterioration in 25%, and dementia in 21% of MHI subjects aged over 50 years, implying that MHI could have rather severe consequences (Mazzucchi, Cattelani, Missale, Gugliotta, Brianti, & Parma, 1992). Houx found that BLE, such as MHI, could accentuate the effect of ‘normal’ biological aging in subjects who considered themselves to be normal and healthy (Houx, Vreeling, & Jolles, 1991b).

The present study elaborates on the possible influence of MHI, sustained more than 3 years ago, on cognitive performance in middle-aged and older subjects. The aim of the study is to evaluate the BLE hypothesis of Houx and Jolles. Specifically, the hypotheses tested were (1) healthy subjects without subjective after-effects of MHI are characterized by objective performance decrements on neurocognitive tests when compared to healthy controls and (2) there is an interaction between age and MHI in their effects on performance. If this hypothesis is not substantiated, then age and MHI should have a cumulative effect.

## MATERIALS AND METHODS

### *Subjects*

Twenty five middle-aged and 20 old subjects, aged 40–59 and older than 60 years, respectively who sustained mild to moderate closed head injury on average 30.5 years ago, were compared to controls in a series of neuropsychological tests. Participants were recruited by means of advertisement in local newspapers. The controls and subjects were matched with respect to age, sex and level of education. The mean age at testing of middle-aged and old MHI subjects was 49.4 and 69.8 years, respectively. The mean age of the controls was 49.4 and 69.2 years, respectively. Middle-aged and old MHI subjects did not differ in the severity of the MHI, the number of years elapsed since MHI, or number of MHI. The average age at which MHI was sustained, however, was lower for middle-aged subjects than for old subjects ( $t=-2.02$ ,  $df=43$ ,  $p<.05$ ). All subjects reported having sustained coma and memory loss, but three middle-aged and seven old subjects reported being free of any postconcussional complaints. All patients considered themselves normal and healthy and to be free from postconcussive symptoms. The groups consisted of 10 male and 10 female subjects.

### *Neuropsychological investigation*

Cognitive testing included the Verbal Learning Test (VLT) (Brand & Jolles, 1985; Lezak, 1995) and the Stroop Color Word Test (Houx, Vreeling, & Jolles, 1993). Predictor variables were presence and severity of MHI, age, level of education (Verhage, 1964), IQ-score (Luteijn & van der Ploeg, 1982), Zung Depression Scale (Zung, 1965), cognitive and neurovegetative complaints after MHI (Bohnen, Twijnstra, & Jolles, 1992), coping style (Schreurs, van de Willige, Tellegen, & Brosschot, 1988), and sleep quality (Mulder-Hajonides van der Meulen, 1981)

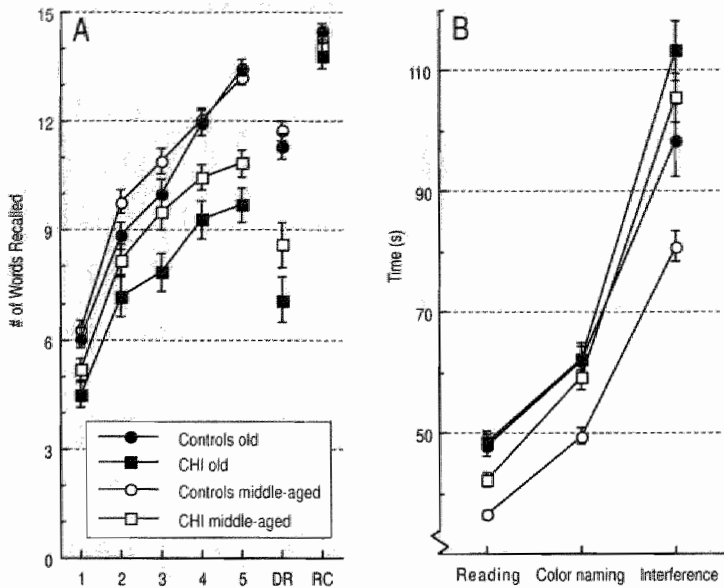
## RESULTS

A decrement in the performance on the VLT trials 1 through 5 was found in MHI subjects (Figure 13.1a). MHI subjects performed significantly worse than their matched controls (repeated measures analysis of variance:  $F(1,86)=43.7$ ,  $p<.001$ ). In addition, repeated measures ANOVA furthermore showed a significant effect of age ( $F(1,86)=6.3$ ,  $p<.05$ ), although this effect was less well pronounced than the effect of MHI. An interaction effect could not be demonstrated ( $F(4,344)=1.00$ , n.s.). The effect of MHI and age found on VLT trials 1 through 5 could also be demonstrated in the 5-trial sum score, suggesting that MHI and aging affected the capacity to learn new material ( $F(1,86)=43.7$ ,  $p<.001$  and  $F(1,86)=6.3$ ,  $p<.05$ , respectively). The maximum score in MHI subjects was 19% lower than in controls (10.9 vs. 13.5:  $F(1,86)=66.6$ ,  $p<.001$ ). This suggests that MHI subjects not only performed worse than the controls, but that they also showed a disproportionate deficit in performance relative to their age peers.

No effects of age on maximum score were found (two-way ANOVA:  $F(1,86)=2.7$ , n.s.). Therefore, the interaction of age with MHI can be attributed to the effect of MHI ( $F(1,86)=5.7$ ,  $p<.05$ ). The delayed recall scores also suggest deficits in active retrieval from memory in MHI subjects ( $F(1,86)=55.5$ ,  $p<.001$ ), without age or interaction effects (respectively  $F(1,86)=3.7$ , n.s. and  $F(1,86)=1.2$ , n.s.). Once information was consolidated, neither MHI nor old subjects encountered any difficulty in passive retrieval of material from memory (respectively  $F(1,86)=2.6$ , n.s. and  $F(1,86)<1$ ), as judged from the delayed recall score. With respect to the Stroop Color Word Interference Test repeated measures ANOVA yielded negative results both for MHI and old subjects ( $F(1,85)=15.0$ ,  $p<.001$  and  $F(1,85)=13.6$ ,  $p<.001$ ) (Fig. 13.1b). These factors simply appeared to add up, for no interaction effect between MHI and age could be found ( $F(2,170)<1$ ). ANOVA showed significant MHI and age effects on all three subtasks; MHI tended to have a stronger impact than age on the performance in subtask I and subtask II, (subtask I: MHI;  $F(1,85)=39.0$ ,  $p<.001$ , age;  $F(1,85)=5.1$ ,

Fig. 13.1.

(a) Mean performance (+SEM) on trials 1 through 5, Delayed Recall (DR) and Recognition (RC) of the Visual Verbal Learning Test for middle-aged and old MHI subjects and their respective control groups. (b) Mean performance (+SEM) on three subtasks of the Stroop Color Word Test, of middle-aged versus old MHI subjects, contrasted with the performance of their optimally healthy age peers.



$p < .05$ ; subtask II: MHI;  $F(1,85)=13.0$ ,  $p < .001$ , and age;  $F(1,85)=5.4$ ,  $p < .05$ ). This did not seem to be the case in subtask III, where performance seemed to be affected mainly by age (respectively MHI:  $F(1,85)=7.1$ ,  $p < .01$ , and age:  $F(1,85)=17.3$ ,  $p < .001$ ). When the amount of interference in subtask III was corrected for the time needed to complete subtask I and subtask II, the effect of MHI disappeared, thus leaving only an interfering effect of age (respectively MHI:  $F(1,85)=2.0$ , n.s., age:  $F(1,85)=16.2$ ,  $p < .001$ ). This means that MHI subjects were slower in reading and in naming colours, but that they did not show any accentuated interference due to MHI. On subtask II, an interaction of age with MHI was found ( $F(1,85)=4.7$ ,  $p < .05$ ), which means that for colour naming older MHI subjects were relatively more affected by MHI than middle-aged subjects who sustained MHI. Coma duration, memory loss, and postconcussional complaints were not in any way correlated with the neuropsychological outcome. As far as the psychological variables were concerned, Zung's self-rating scale for depression turned out to be positively correlated with performance on Stroop subtask I and II ( $r=.47$ ,  $p < .01$  and  $r=.41$ ,  $p < .01$ , respectively). According to normative data derived from a normal, healthy population (Zung & Durham, 1973), the MHI subjects in the present study could not be characterized as being depressed. Thus, the inferior performance on Stroop I and II (i.e. slowness) correlates with dysthymic symptoms. Furthermore, MHI subjects who tended to show dysthymic symptoms had a lower perceived quality of sleep ( $r=.55$ ,  $p < .001$ ), more cognitive and emotional complaints, and a more depressive reaction pattern, as

measured by the coping list (subscale 5;  $r=.76$ ,  $p<.001$ ;  $r=.72$ ,  $p<.001$ , and  $r=.67$ ,  $p<.001$ , respectively). Intelligence in MHI subjects tended to be negatively correlated to self-ratings of depression ( $r=-.36$ ,  $p<.01$ ). Active problem solving, tended to be positively correlated with intelligence ( $r=.41$ ,  $p<.01$ ) and negatively with complaints concerning sleep, and emotional and cognitive complaints ( $r=-.39$ ,  $p<.01$ ,  $r=-.43$ ,  $p<.01$  and  $r=-.46$ ,  $p<.01$ , respectively). Depressive reaction patterns correlated with complaints concerning sleep ( $r=.35$ ,  $p<.05$ ), but more strongly with emotional and cognitive complaints (for both  $r=.64$ ,  $p<.001$ ). Finally, there also was a strong correlation between the depressive reaction as measured by the coping style list and Zung ( $r=-.67$ ,  $p<.001$ ).

## DISCUSSION

The most striking finding in this study is that healthy subjects who had experienced a mild head injury years ago (from which they had recovered completely, as judged from their self-perceived health) performed worse than their matched controls on cognitive tests. There were no robust correlations between indices of the severity of MHI and neuropsychological outcome. This suggests that the cognitive sequelae in a population who sustained MHI on average 30.4 years ago, are at least relatively independent of the severity of the injury. From the scores on the Stroop Test, we found that the performance of middle-aged MHI subjects was very similar to that of old controls. Older MHI subjects, however, did not perform disproportionately worse than younger MHI subjects. In combination with the VLT maximum and delta scores, these scoring patterns could be used as indicators of accelerated cognitive aging due to the effect of MHI. In middle-aged MHI subjects, the usual age-related decline in cognitive functioning seemed to occur at an earlier time than in age-peers who were not affected by MHI.

The fact that MHI subjects did not complain about their cognitive limitations suggests a possible role of coping strategies. Middle-aged subjects showed a somewhat more active attitude, i.e. they tended to show more palliative behaviour and tended to seek more social support than did old MHI subjects, although only the latter difference proved to be statistically significant. Our MHI subjects had an average intelligence score which was somewhat higher than that of the general Dutch population. The more intelligent subjects showed lower self-ratings of depression and a stronger tendency to active problem solving. The more intelligent a subject is, the more capable he or she appears to be to compensate for neuronal loss, and the more likely he or she will be able to deal with cognitive challenges in every-day life. When we take into account the advantageous role of intelligence in coping with everyday-life situations, this might have been an important contributor to the lack of long-term neurasthenic symptoms in our MHI subjects. Another factor

probably accounting for the discrepancy between neuropsychological outcome and complaints concerning cognition is that self-ratings were used for severity of MHI. Because post-traumatic amnesia obscures the recall of facts related to injury, the MHI subject usually is not able to give a reliable report, his or her comparison is therefore with the pre-traumatic state. We might, however, question whether in mild MHI recall is as strongly affected as it is in moderate to severe MHI. Another factor possibly contributing to the discrepancy might be the fact that subjective reports on events that took place a long time ago tend to be rather unreliable regardless of the possible effects of post-traumatic amnesia. In our study, the subjective report might thus actually have been an underestimation of the initial coma duration or memory loss.

In conclusion, this study shows that although MHI subjects might be characterized by objective cognitive deficits or even an accelerated cognitive aging, they may not have cognitive complaints. The fact that they sustained MHI many years ago might have been an important factor contributing to this lack of complaints. Recovery is probably influenced by the premorbid level of intelligence, mental stability, and family support, and the process of recovery is thus influenced by the ability to allocate these personal resources. Evaluation and comprehensive cognitive rehabilitation after MHI should therefore always consider the impact of neurological, demographical, psychological and environmental factors.

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